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IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

PATENT APPLICATION

CASE: LIN-2

TITLE: METHOD OF PROCESSING DIVERSE THREE-DIMENSIONAL
GRAPHIC OBJECTS

THE ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Enclosed are the following papers relating to the above-named application for patent:

Specification
5 Informal sheets of drawing(s)
Executed Declaration and Power of Attorney
Assignment with Coversheet
Verified Statement Claiming Small Entity Status
Express Mail Label No. EH896345489US
Certificate of Mailing by "Express Mail"
1 Post Card
Check No. 159505 in amount of \$380 for filing fee
Check No. 159501 in amount of \$40.00 for recordation fee

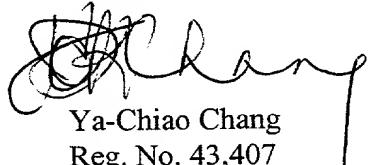
CLAIMS AS FILED				
	NO. FILED	NO. EXTRA	RATE	CALCULATIONS
Total Claims	1 - 9	0	x \$9.00	\$0.00
Independent Claims	3	0	x \$39.00	\$0.00
Multiple Dependent Claim(s), if applicable			x \$130	\$0.00
Basic Fee				\$380.00
			TOTAL FEE:	\$380.00

Enclosed is check no. in the amount of \$380.00 to cover the filing fee and check no. for \$40.00 to cover the recordation fee. Duplicate copies of this letter are enclosed. In the event

of non-payment or improper payment of a required fee, the Commissioner is authorized to charge or to credit **Deposit Account No. 03-3839** as required to correct the error.

Please address all correspondence to **Intellectual Property Docket Administrator, Gibbons, Del Deo, Dolan, Griffinger & Vecchione, One Riverfront Plaza, Newark, New Jersey 07102-5497**. However, telephone calls should be made to me at Area Code (973) 596-4881, or (973) 596-4500.

Respectfully,



Ya-Chiao Chang
Reg. No. 43,407
Attorneys for Applicant

Date: April 13, 1999

**Intellectual Property Docket Administrator
Gibbons, Del Deo, Dolan, Griffinger & Vecchione
One Riverfront Plaza
Newark, New Jersey 07102-5497**

Applicant or Patentee: Tsung-Wei LIN Attorney's
 Serial or Patent No.: _____ Docket No.: _____
 Filed or Issued: _____
 For: METHOD OF PROCESSING DIVERSE THREE-DIMENSIONAL GRAPHIC OBJECTS

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
 (37 CFR 1.9(f) and 1.27 (c)) - SMALL BUSINESS CONCERN**

I hereby declare that I am

the owner of the small business concern identified below:
 an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN Ulead Systems, Inc.

ADDRESS OF CONCERN 10F, 45 Tung Hsing Road, Taipei, Taiwan, R.O.C.

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled METHOD OF PROCESSING DIVERSE THREE-DIMENSIONAL GRAPHIC OBJECTS

by inventor(s) Tsung-Wei LIN

described in

the specification filed herewith
 application serial no. _____, filed _____
 patent no. _____, issued _____

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e). *NOTE: Separate verified statements are required from each person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME _____

ADDRESS _____

INDIVIDUAL SMALL BUSINESS CONCERN NONPROFIT ORGANIZATION

FULL NAME _____

ADDRESS _____

INDIVIDUAL SMALL BUSINESS CONCERN NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING Way-Zen CHEN

TITLE OF PERSON OTHER THAN OWNER Executive Vice President

ADDRESS OF PERSON SIGNING 10F, 45 Tung Hsing Road, Taipei, Taiwan, R.O.C.

SIGNATURE way-zen chen DATE 1999/3/30

METHOD OF PROCESSING DIVERSE
THREE-DIMENSIONAL GRAPHIC OBJECTS

BACKGROUND OF THE INVENTION

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Field of the Invention

The present invention generally relates to computer graphics. More particularly, the present invention relates to a method of processing diverse graphic objects that are rendered visually three-dimensional (3D) by relation map function.

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Description of the Related Art

The growing popularity of computers has enabled conventional film clips, graphics and pictures to be digitized for computer processing, allowing special visual effects never before possible. Computer imaging or graphing is also gaining a foothold in almost every profession because of the widespread use of computers. However, the restricted features of the video display and the computer have made typical computer applications more suitable for processing 2-D graphic objects and for presenting 2-D effects rather than for processing 3-D graphic objects and presenting 3-D effects.

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The conventional method for achieving 3-D effect uses the polygonal approach. In said polygonal approach, a 2-D planar graphics is first determined and segmented into a plurality of polygons with computer operations. Then an interpolation operation is performed to change the associated color value of the pixels of each polygon to render 3-D visual effects. Generally speaking, the 2-D original graphic is usually composed of smooth curves of polynomials and the smooth and gradual visual effect is usually desired. Whereas, the effect of conventional method using plural polygons to change the color values of the pixels is not so satisfactory. For

example, if not enough polygons applied, the zigzag distortion will happen on the lines corresponding to the curves of the 2-D original graphic. Thus, the visual effect is adversely affected.

5 In another way, if the applied polygons are increased to avoid the above-mentioned problem, the processing time will be considerably increased. Additionally, if different kinds of visual effects are desired on a 2-D original graphic, every corresponding segmenting way may be accordingly different and 10 the processing time can be also increased.

Another processing method of rendering 3-D graphic effects with a 2-D graphic object is disclosed in the U.S. Patent 15 No. 5,828,380 assigned to Ulead Systems, Inc. In said processing method, a relation map function is first given for each pixel of the graphic to obtain the directional relation of the corresponding 2-D graphic object. The required 3-D imaging effects, such as generating the measurement of length corresponding to the third axis (i.e., z-axis), can be generated from the acquired directional relation through an effect 20 function to actualize 3-D visual effects.

Figure 1 is a diagram illustrating the relation map function of the prior art. For example, a 2-D graphic object is a ring-shape area confined by an outer curve 40 and an inner curve 41. In the drawing, the graphic object is composed of 25 numerous pixels, such as A1, A2, and A3. In said processing method, a relation map function corresponding to pixels of the 2-D original graphics is first obtained, which represents a distance or a vector from every pixel to the corresponding edge of the curves 40 or 41 located closest thereto. In Figure 1, 30 the relation map function represents the directional relation of the vectors from every pixel to the edges located closest thereto, such as V1, V2, and V3.

Then, an effect function is used to render the 2-D graphic

object visually three-dimensional. As to the effect function, a relation limit d_{max} and a predetermined contour curve should be defined. Only those pixels within the range of the distance d_{max} from the edge of the 2-D graphic object are subjected to 5 3-D processing such as effect on relation map (ERM) functions, whereas the z-axis coordinate of each pixel within that range can be determined by the predetermined contour curve, accordingly.

10 Figs. 2a-2c illustrate three possible contour curves in accordance with the effect function. Fig. 2a is a type of rounded bevel, with C1 denoting a contour curve, and the coordinate of the pixel (x, y) starting from the edge within a relation limit d_{max} determines the corresponding coordinate on the axis z in accordance with said contour curve C1. Further, 15 Fig. 2b is a type of straight bevel, with C2 denoting a contour curve; and Fig. 2c a combined type of two rounded bevels, with C3 denoting a contour curve.

20 Taking the rounded bevel type of Fig. 2a as an example, assume the distance from the coordinate of the pixel (x, y) to the edge of the corresponding edge is $L (= \sqrt{x^2 + y^2})$; then the z-axis parameters of said pixel (x, y) can be determined as follows:

$$z = L \times \tan[\cos^{-1}((d_{max} - L)/d_{max})] \quad (1)$$

25 The computations of z-axis parameters under other circumstances can also be made in a similar manner. In other words, the z-axis coordinate corresponding to each pixel within the relation limit d_{max} in the above contour curves can be calculated with mathematical equations.

30 Though the conventional effect function may rapidly render visually 3-D effects with quite simple operations processing, its application still demonstrates some inadequacies. First, it is restricted by the inflexibility of

the relation limit d_{max} in that the portion to be 3-D mapped can only be displayed in a symmetrical pattern. Referring to Figure 3, wherein the outer curve defines the area of a 2-D graphic object, the portion to be 3-D mapped is within the range 0 to 5 d_{max} . Figures 4a-4c are diagrams illustrating a stereograph of a 3-D graphic object of Figure 3 processed with rounded bevel, straight bevel and two-rounded bevels, respectively. As observed from Figures 4a-4c, the rendered stereographs are definitely in symmetrical curves. However, even some 3-D model 10 objects (such as pyramids or cones) with a particular symmetrical pattern will show unsymmetrical visual effects when observed from various perspectives. The conventional method 15 can not realize such asymmetrical visual effect.

Second, all the contour curves, such as rounded bevel, straight bevel, two-rounded bevels as shown in Figure 2a-2c must 20 be expressed by mathematics formula, and therefore fail to demonstrate a variety of stereographs because of the limited variations of the rigid contour curves and their identical orientations. In summary, the effect function as adopted in the prior art encounters difficulty in rendering diversified graphics.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention 25 to provide a processing method capable of performing variations and creating diversified 3-D graphic objects through an effect function used in the process of rendering 2-D graphic objects to 3-D graphic objects.

According to the above object, the present invention 30 provides a method of rendering a 2-D graphic object having a plurality of pixels to a 3-D graphic object. At first, a directional relation corresponding to the pixels is determined to define relations between the pixels and edges of the 2-D

graphic object. Then, z-axis parameters corresponding to the pixels are generated in response to the directional relation with an effect function, wherein the effect function renders the z-axis parameters responsive to a relation limit varied with 5 directions of the directinoal relation or a mapping table defining offset values of the z-axis parameters, or both. Finally, the 3-D graphic object is rendered in response to the 2-D graphic object and the z-axis parameters.

10 BRIEF DESCRIPTION OF THE DRAWINGS

The aforementioned objects, features and advantages of this invention will become apparent by referring to the following detailed description of preferred embodiments with reference to the accompanying drawings, wherein:

15 Figure 1 is a diagram illustrating a relation map function of a graphic in prior art;

20 Figures 2a - 2c are diagrams illustrating three prospective contours, wherein Figure 2a is a type of a rounded bevel, Figure 2b is a type of straight bevel, and Figure 2c is a combined type of two rounded bevels;

25 Figure 3 is a diagram illustrating the range of the relation limit of a round graphic object;

30 Figures 4a-4c are diagrams illustrating a stereograph (3-D modeling) of the 3-D graphic object of Figure 3 processed with rounded bevel, straight bevel and two-rounded bevels, respectively;

Figure 5 is a diagram illustrating an example within the range of various relation limits in accordance with the first embodiment of the present invention;

35 Figure 6 is a diagram illustrating a stereograph of a 3-D graphic object rendered with various relation limits provided by a mapping table in accordance with the first embodiment of the present invention; and

Figure 7 is a diagram illustrating a stereograph of a 3-D graphic object rendered with various borders and depths.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

5 The processing method of rendering diversified 3-D graphic objects as disclosed in this invention is realized by changing the effect function $E(\cdot)$. It is known from the effect function of the prior art (such as Figures 2a, 2b and 2c) that the rendered effect is mainly controlled by two variables, 10 namely, the relation limit d_{\max} and the contour curves (C1, C2, and C3). The relation limit d_{\max} specifies the range of variations in the 3-D modeling area, whereas the contour curves specifies the type of variation within said range, for corresponding respectively to the border and the depth of a 3-D graphic object in terms of actual visual effect. Actual 15 contents will be described in a respective embodiment with reference to the drawings.

First Embodiment (Variable Relation limit)

20 The relation limit d_{\max} of effect function $E(\cdot)$ in the prior art is a fixed value, that is, the rendered 3-D graphic object shows a certain symmetry as shown in Figure 3. In this embodiment, the relation limit is set as a function for the orientation of the pixel vector mapping. Consequently, the 25 borders vary according to various directions or orientations.

Figure 5 is a diagram illustrating an example within the range of various relation limits in accordance with the first embodiment of the present invention. Figure 5 illustrates an example with an elliptical area relation limit. As shown in the figure, the maximal relation limit is d_{\max} , and the relation limit d of other orientations is a function of angle θ formed with its direction on x-axis. So the effect function can be 30 represented as $E(v, d(\theta, d_{\max}), C)$, wherein v represents

directional relation of pixels, C its corresponding contour curve, and the relation limit d is a function of the maximal length d_{\max} and its angle θ .

In the case of the ellipse of Figure 5, the length of
5 d/d_{\max} at the direction d can further be given as:

$$(d/d_{\max})|_{d\text{-direction}} = \frac{d_{\max} + b - \sqrt{a^2 \cos^2 \theta + b^2 \sin^2 \theta}}{d_{\max}} \quad (2)$$

Therein, a is a long axis, b a short axis, θ an angle formed between the direction d and the direction of the short axis; $(d_{\max}+a) > b$; and $a, b > 0$. Therefore, various borders can be
10 rendered for various directions with the definition of the relation limit.

The adaptability of this embodiment also applies to a 3-D symmetrical object observed from various angles.

Referring to Figure 6, a diagram illustrates a stereograph (3-D modeling) of a 3-D graphic object rendered with a relation limit of various borders. As shown in the drawing, the 3-D object is originally a conical object with its top portion cut off, similar to that as shown in Figure 4b, where the observer perceives from a downwardly skewed angle. Therefore, the
15 cut-off top portion is in an upwardly skewed position (compare and contrast with Figure 4b). Figure 6 illustrates a 3-D graphic rendered with the area of the relation limit of the borders and a 3-D modeling process.

25 Second Embodiment (Variable Contour Curve)

The outlook of a 3-D graphic object is changed through the contour curve C in this embodiment. In the prior art, the contour curve is used to define the z-axis parameter for the distance 0 (edge grid EG) to the maximal relation limit d_{\max} in
30 all orientations. In this embodiment, however, a mapping table α is added to the contour curve, each item of which corresponds

to a pixel of the original 2-D graphic object adjusts its z-axis parameter.

Hence, the effect function during the rendering of a diversified graphic through the mapping table may be represented as $E(v, d_{max}, C, \alpha)$, allowing the display of diversified graphics of the 3-D graphic object in practical applications. Meanwhile, the original contour can be omitted when the z-axis parameter is adjusted through the mapping table.

The border is adjusted in the first embodiment and the depth is adjusted in the second embodiment; however, they can both be applied simultaneously. At that time, the effect function can be represented as $E(v, d(\theta, d_{max}), C, \alpha)$. Figure 7 is a diagram illustrating a stereograph of a 3-D graphic object rendered with various borders and depths. The control of the relation limit and the addition of a mapping table enable variations of the 3-D graphic object; therefore, the object of this invention is realized.

Although the present invention has been described in its preferred embodiments, it is not intended to limit the invention to the precise embodiment disclosed herein. Those who are skilled in this technology can still make various alterations and modifications without departing from the scope and spirit of this invention. Therefore, the scope of the present invention shall be defined and protected by the following claims and their equivalents.

What is claimed is:

1 1. A method of rendering a 2-D graphic object, having a
2 plurality of pixels, to a 3-D graphic object, comprising the
3 following steps of:

4 determining a directional relation corresponding to said
5 pixels, wherein said directional relation defines relations
6 between said pixels and edges of said 2-D graphic object;

7 generating z-axis parameters corresponding to said pixels
8 in response to said directional relation with an effect function,
9 wherein said effect function renders said z-axis parameters
10 responsive to a relation limit varied with directions of said
11 directional relation; and

12 rendering said 3-D graphic object in response to said 2-D
13 graphic object and said z-axis parameters.

1 2. The method as claimed in claim 1, wherein each of said
2 pixels comprises red data, blue data, green data and alpha
3 channel data.

1 3. The method as claimed in claim 1, wherein each of said
2 directional relation defines relative edge positions of said
3 2-D graphic object closest to said pixels.

1 4. A method of rendering a 2-D graphic object, having a
2 plurality of pixels, to a 3-D graphic object, comprising the
3 following steps of:

4 determining a directional relation corresponding to said
5 pixels, wherein said directional relation defines relations
6 between said pixels and edges of said 2-D graphic object;

7 generating z-axis parameters corresponding to said pixels
8 in response to said directional relation with an effect function,
9 wherein said effect function renders said z-axis parameters

10 responsive to a mapping table defining offset values of said
11 z-axis parameters; and

12 rendering said 3-D graphic object in response to said 2-D
13 graphic object and said z-axis parameters.

1 5. The method as claimed in claim 4, wherein each of said
2 pixels comprises red data, blue data, green data and alpha
3 channel data.

1 6. The method as claimed in claim 4, wherein each of said
2 directional relation defines relative edge positions of said
3 2-D graphic object closest to said pixels.

1 7. A method of rendering a 2-D graphic object, having a
2 plurality of pixels, to a 3-D graphic object, comprising the
3 following steps of:

4 determining a directional relation corresponding to said
5 pixels, wherein said directional relation defines relations
6 between said pixels and edges of said 2-D graphic object;

7 generating z-axis parameters corresponding to said pixels
8 in response to said directional relation with an effect function,
9 wherein said effect function renders said z-axis parameters
10 responsive to a relation limit varied with directions of said
11 directional relation, a contour curve, and a mapping table
12 defining offset values of said z-axis parameters; and

13 rendering said 3-D graphic object in response to said 2-D
14 graphic object and said z-axis parameters.

1 8. The method as claimed in claim 7, wherein each of said
2 pixels comprises red data, blue data, green data and alpha
3 channel data.

1 9. The method as claimed in claim 7, wherein each of said

2 directional relation defines relative edge positions of said
3 2-D graphic object closest to said pixels.

ABSTRACT OF THE DISCLOSURE

A method of rendering a 2-D graphic object having a plurality of pixels to a 3-D graphic object is disclosed. At first, a directional relation corresponding to the pixels is 5 determined to define relations between the pixels and edges of the 2-D graphic object. Then, z-axis parameters corresponding to the pixels are generated in response to the directional relation with an effect function, wherein the effect function renders the z-axis parameters responsive to a relation limit 10 varied with directions of the directional relation or a mapping table defining offset values of the z-axis parameters, or both. Finally, the 3-D graphic object is rendered in response to the 2-D graphic object and the z-axis parameters.

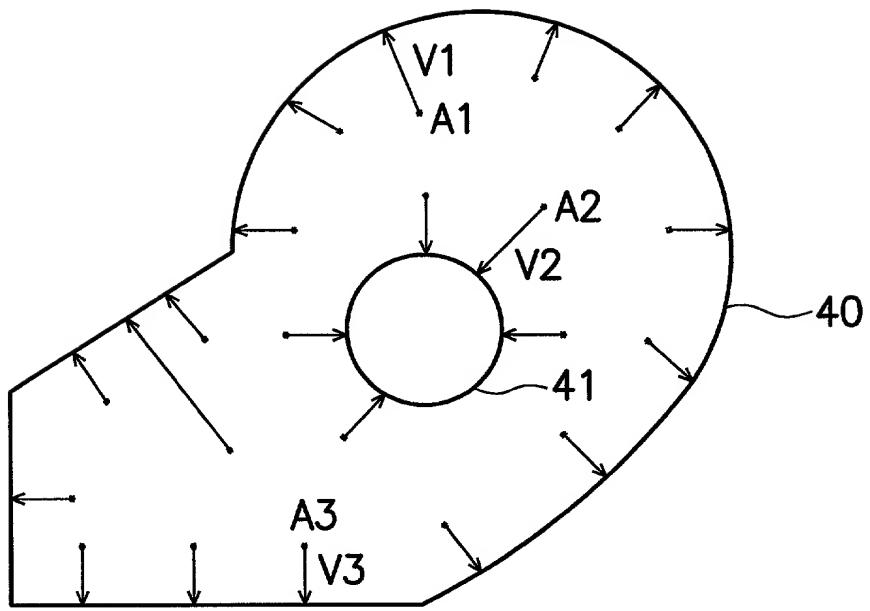


FIG. 1 (PRIOR ART)

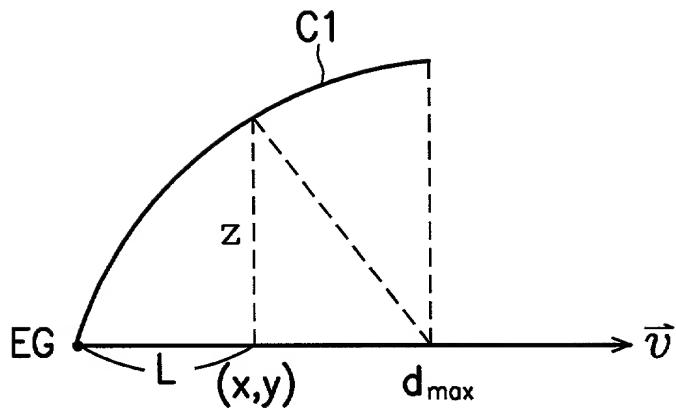


FIG. 2a (PRIOR ART)

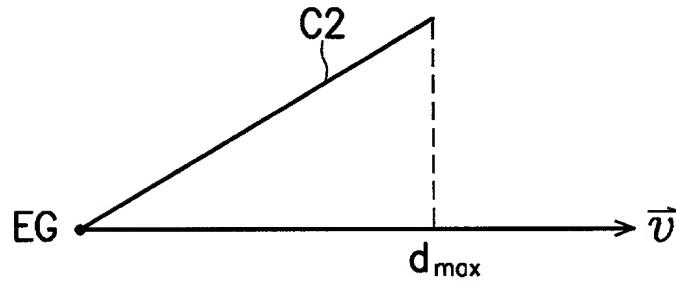


FIG. 2b (PRIOR ART)

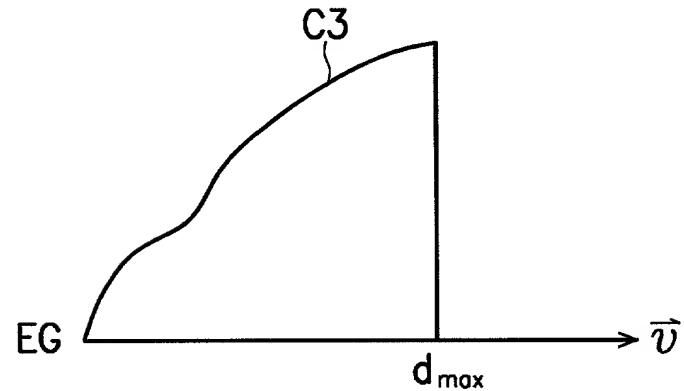


FIG. 2c (PRIOR ART)

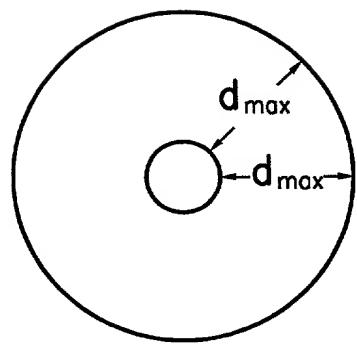


FIG. 3 (PRIOR ART)

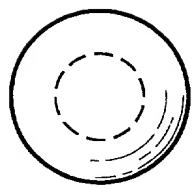


FIG. 4a (PRIOR ART)

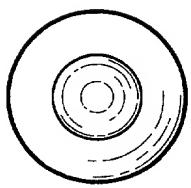


FIG. 4b (PRIOR ART)

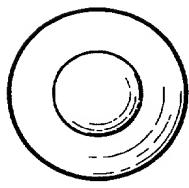


FIG. 4c (PRIOR ART)

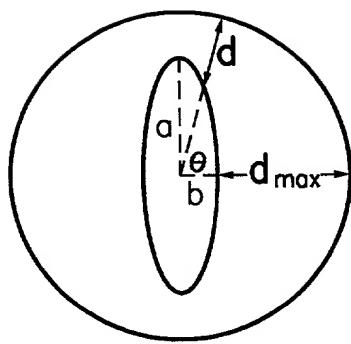


FIG. 5

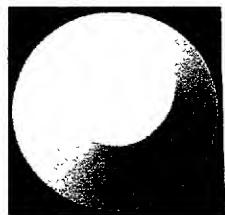


FIG. 6

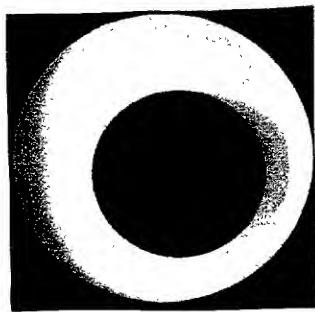


FIG. 7

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Declaration and Power of Attorney

As the below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled METHOD OF PROCESSING DIVERSE THREE-DIMENSIONAL GRAPHIC OBJECTS, the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Number	Country	Day/Month/Year Filed	Priority Claimed
87116023	Taiwan, R.O.C.	25/09/1998	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>

I hereby claim the benefit under Title 35, United States Code, 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

None

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith:

I hereby appoint the attorney(s) on ATTACHMENT A as associate attorney(s) in the aforementioned application, with full power solely to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected with the prosecution of said application. No other powers are granted to such associate attorney(s) and such associate attorney(s) are specifically denied any power of substitution or revocation.

Full name of Inventor: Tsung-Wei LIN

Inventor Signature: ✓ Tsung-Wei Lin

✓ Date: March 20, 1999

Residence: same as the post office address

Citizenship: Taiwan, R.O.C.

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Taiwan, R.O.C.

ATTACHMENT A

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<u>John A. Ligon</u>	<u>35,938</u>
<u>Ya-Chiao Chang</u>	<u>43,407</u>
<u>Vincent McGeary</u>	<u>42,837</u>
<u>Diane Ferone</u>	<u>36, 135</u>

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Phone No.: 973-596-4881 or 973-596-4500

Fax No.: 973-639-6291 or 973-596-0545

All written communications are to be addressed to:

**Intellectual Property Docket Administrator
Gibbons, Del Del, Dolan, Griffinger & Vecchione
One Riverfront Plaza, Newark, New Jersey 07105-5497**